Donut Analysis with Root

Reinhard Schwienhorst

University of Minnesota

Long report

E872 phone meeting, 6/29/99

Outline

- Root
- Donut analysis
- Root and Donut
- Emulsion data tree
- Histograms, tracks
- Magnetic moment analysis
- Result
- Root outlook

Root introduction

- Data analysis framework
  - Object oriented
  - C++ based
- developed at CERN by Rene Brun, Fons Rademakers
- many people, experiments are now using root
  - NA49, ATLAS, RHIC, STAR, ALICE, HADES,…
- Root is the successor to PAW, Geant, CERNLIB

Donut analysis (to date)

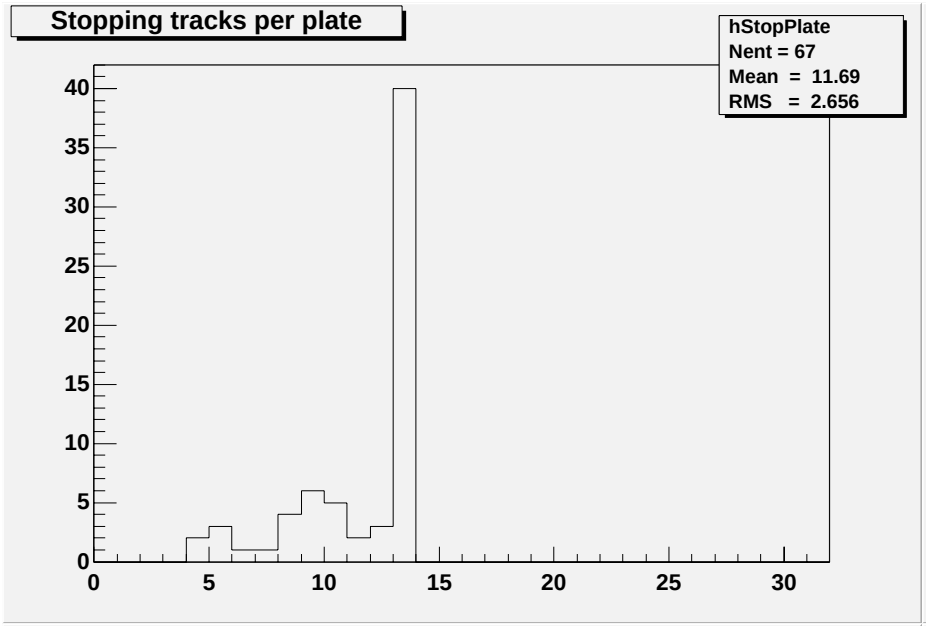
- Spectrometer data is analyzed with Fortran/Cernlib based software
- Emulsion data is analyzed in Nagoya
  - alignment in a C program (Aoki)
  - vertex finding:
    - in a simple C program (Aoki)
    - visually (Okada, using software based on Aokis C code)
    - in a Fortran program (Komatsu)
    - also here in the US in connection with the spectrometer (Bruce)

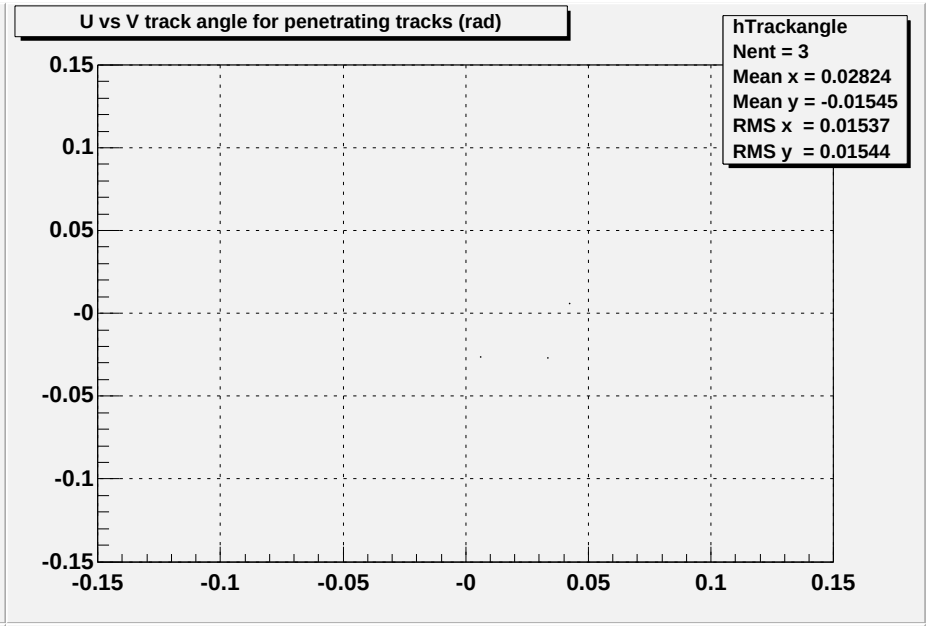
Root and Donut

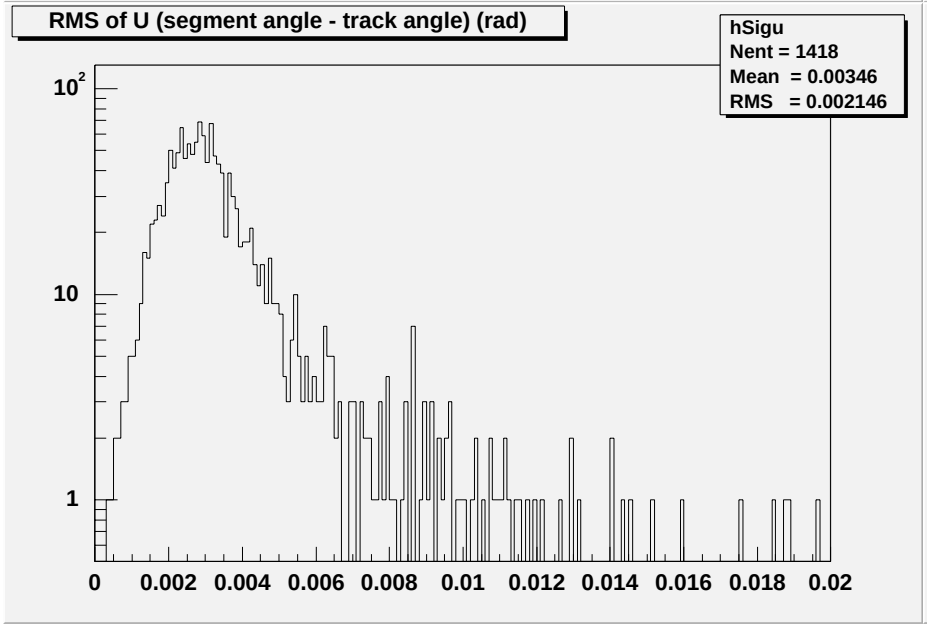
- Emulsion data: OO
  - Emulsion track segments
  - Emulsion tracks
  - Vertices
  - (Spectrometer tracks)
- We are starting to analyze emulsion data
  - alignment?
  - Vertex finding
  - decay search
  - magnetic moment analysis
- Some analysis tools (routines) to do this work exist
  - there are different tools for different tasks
  - there are no tools do decay search or my μ_ν analysis

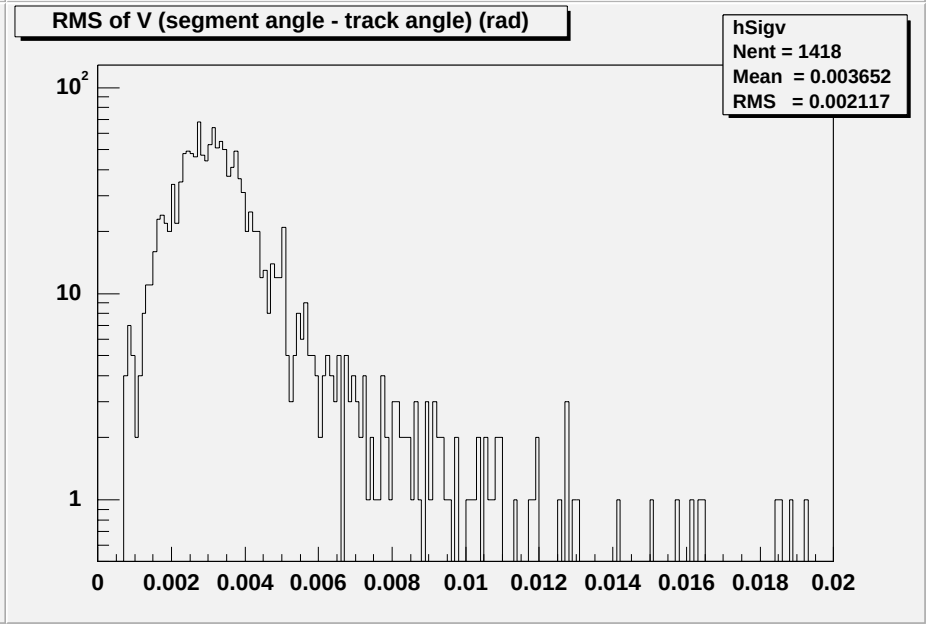
Donut Root Tree

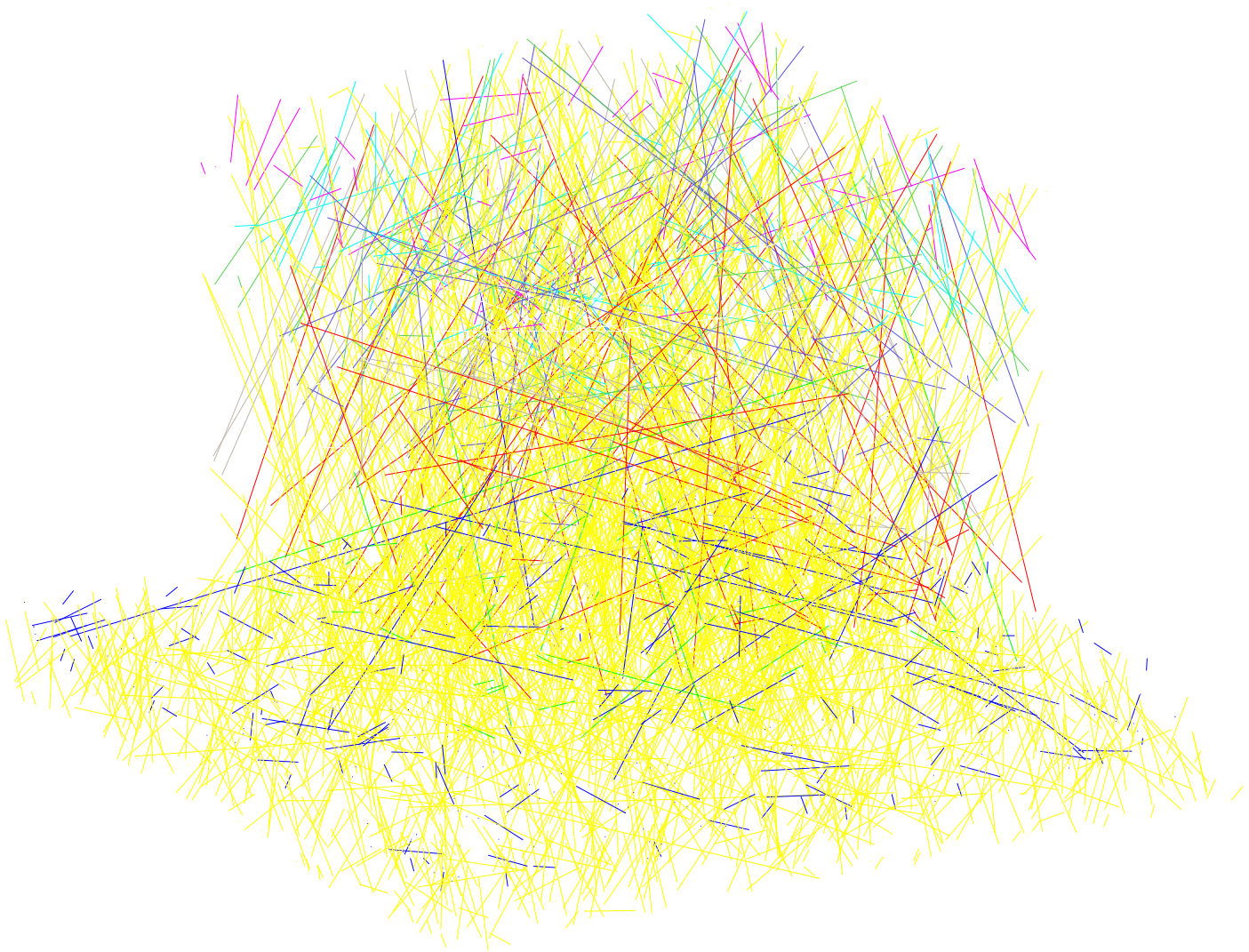
- I started to put emulsion information into a root framework
- The “Tree” has branches:
  - event information (run, event number, scan volume, …)
  - emulsion track segment information
  - emulsion track information
  - spectrometer track information
  - emulsion vertex information
  - 4 histograms (stopping tracks/plate; U,V angle alignment; track angle)

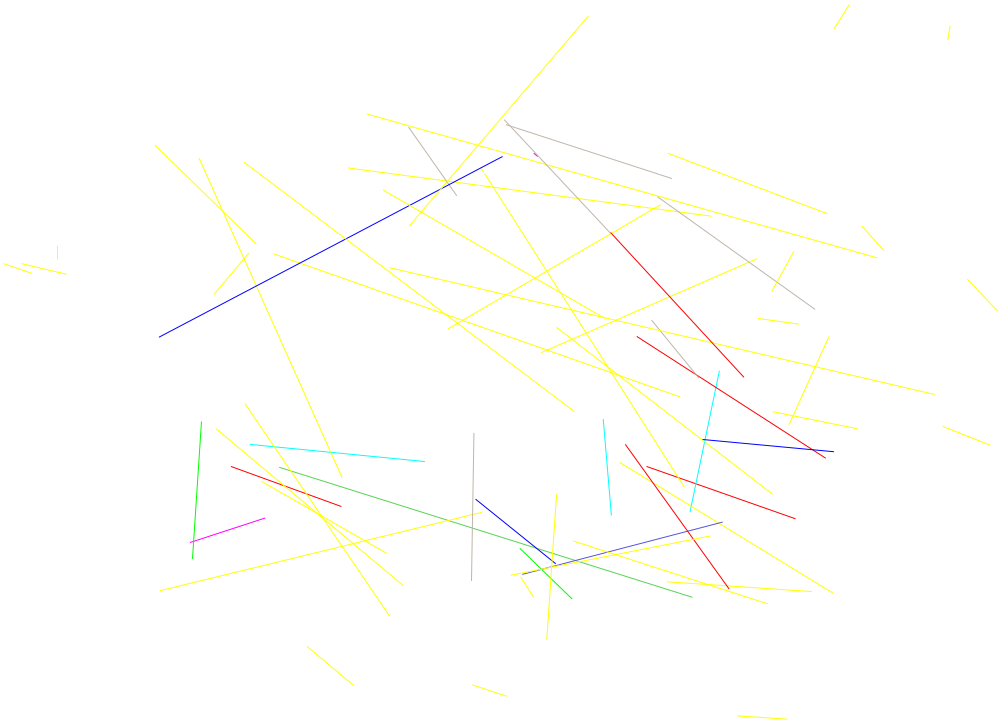

Stopping tracks per plate
hStopPlate
Nent = 67
Mean = 11.69
RMS = 2.656
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30


U vs V track angle for penetrating tracks (rad)
hTrackangle
Nent = 3
Mean x = 0.02824
Mean y = -0.01545
RMS x = 0.01537
RMS y = 0.01544
0.15
0.1
0.05
-0
-0.05
-0.1
-0.15
-0.15
-0.1
-0.05
-0
0.05
0.1
0.15


RMS of U (segment angle - track angle) (rad)
hSigu
Nent = 1418
Mean = 0.00346
RMS = 0.002146
10²
10
1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

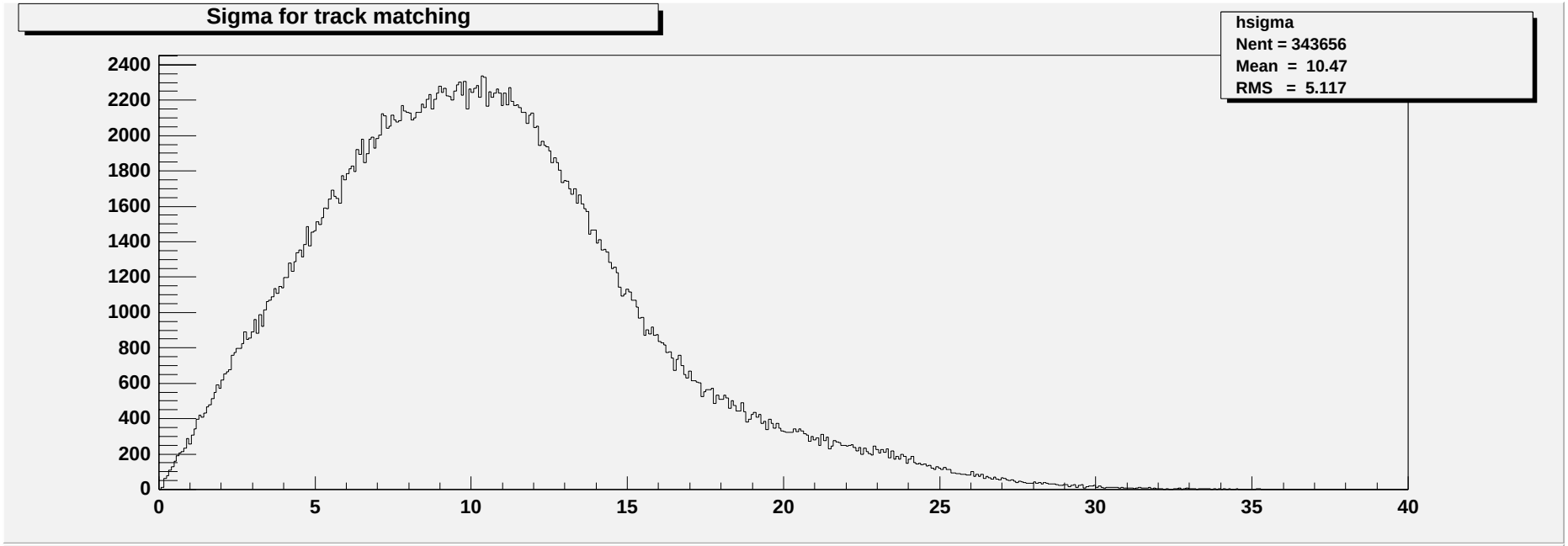

RMS of V (segment angle - track angle) (rad)
hSigv
Nent = 1418
Mean = 0.003652
RMS = 0.002117
10²
10
1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

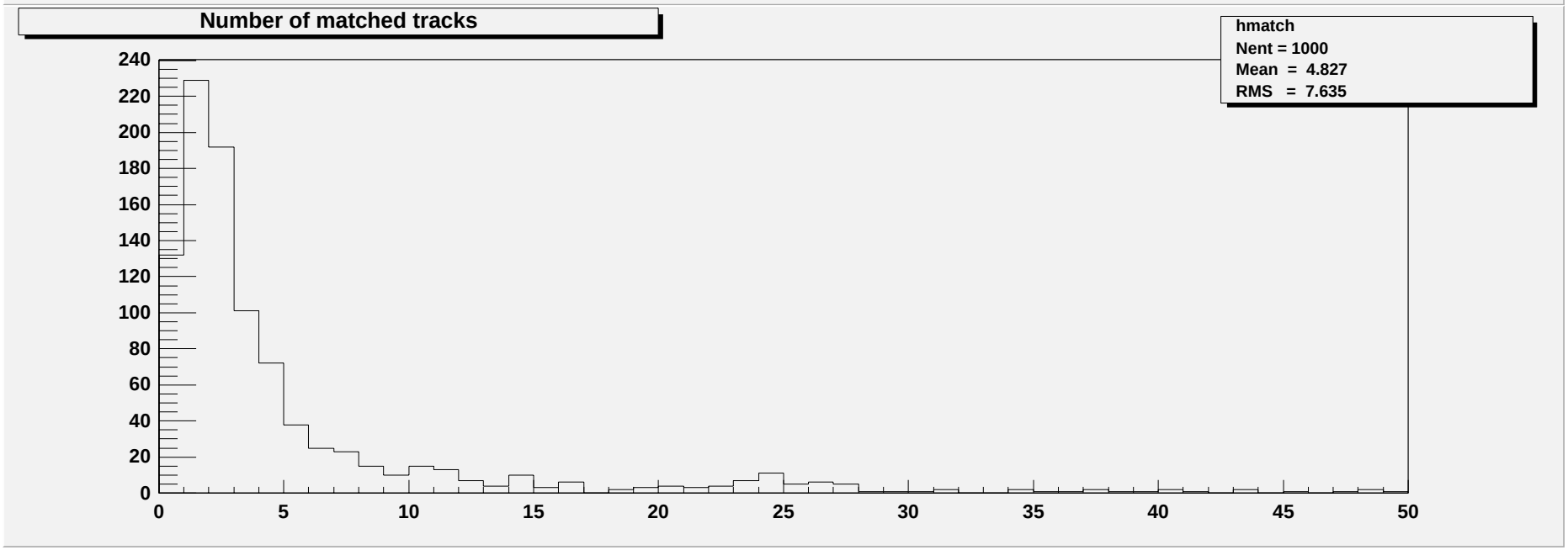


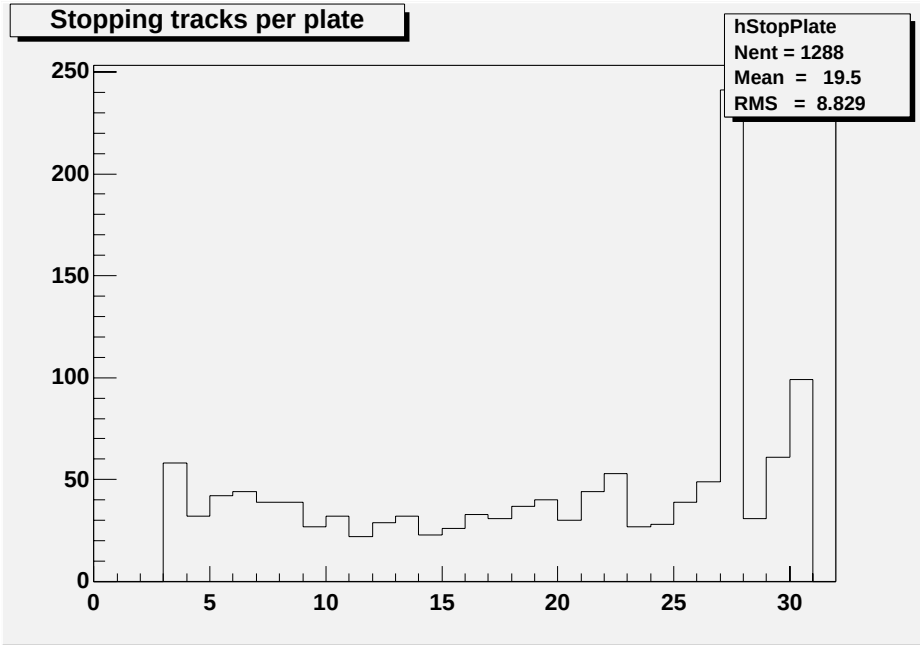


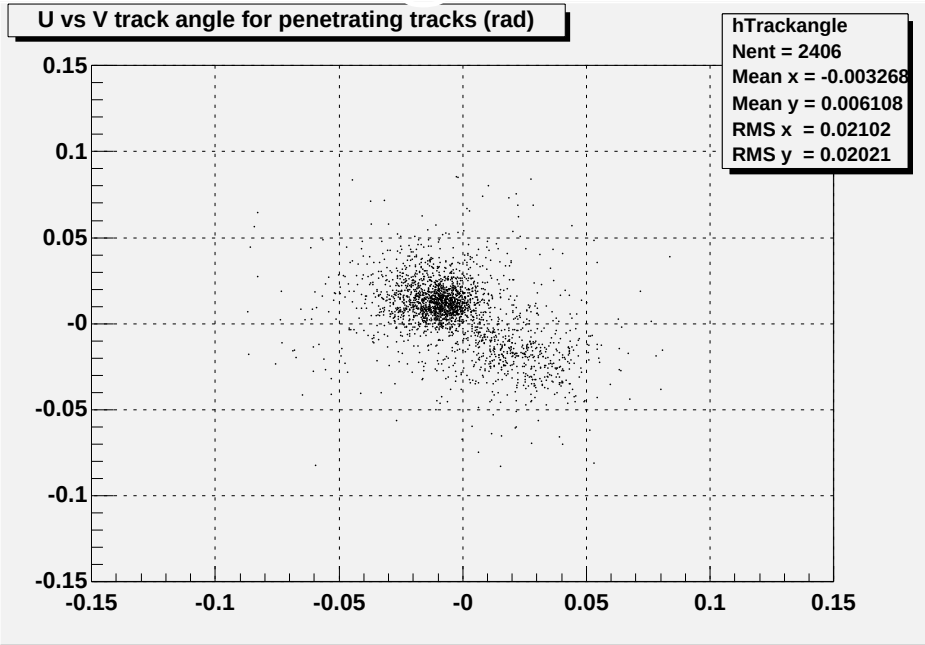
Magnetic moment analysis

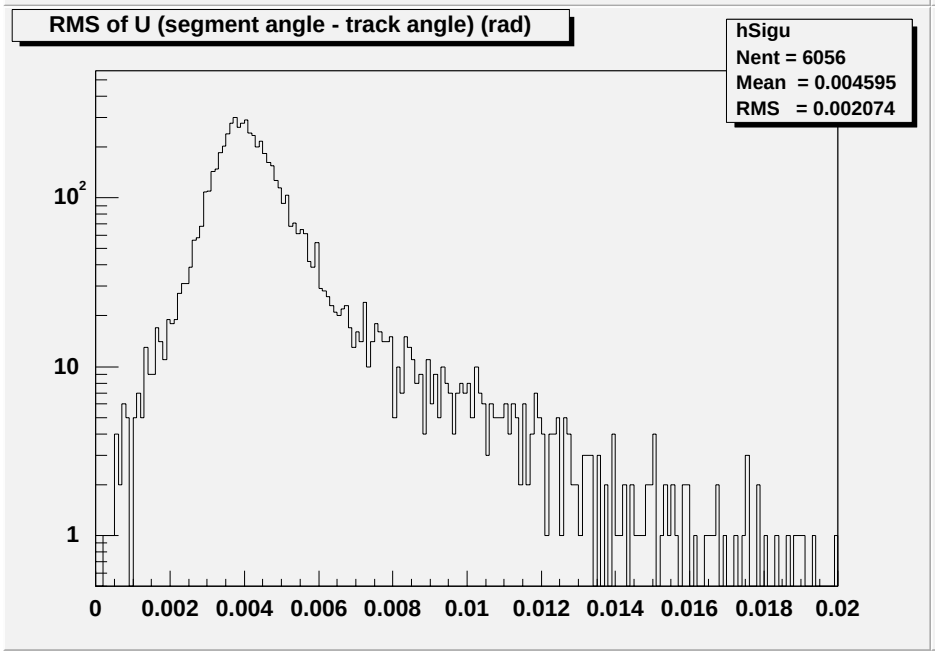
- My candidate event sample contains events with single tracks
- I prepared predictions for a scanning volume
- The events were scanned in Nagoya
- Analysis:
  - match spectrometer track to stopping tracks
    - 90% CL volume in u,v,θu, θv space
  - check: create a random track and match to stopping tracks

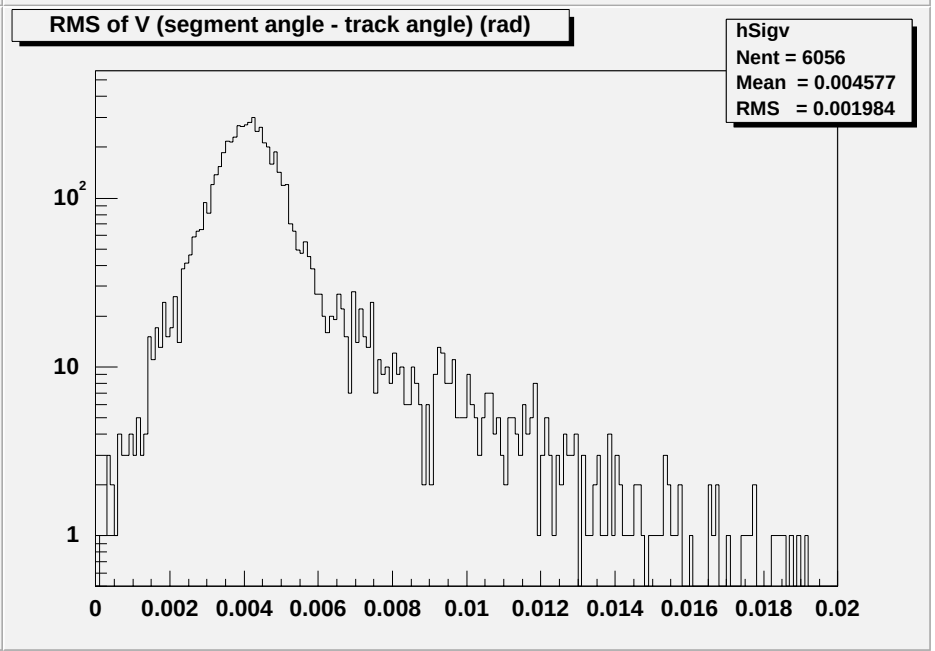

Sigma for track matching
hsigma
Nent = 343656
Mean = 10.47
RMS = 5.117
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40


Number of matched tracks
hmatch
Nent = 1000
Mean = 4.827
RMS = 7.635
240
220
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50


Stopping tracks per plate
hStopPlate
Nent = 1288
Mean = 19.5
RMS = 8.829
250
200
150
100
50
0
0
5
10
15
20
25
30


U vs V track angle for penetrating tracks (rad)
hTrackangle
Nent = 2406
Mean x = -0.003268
Mean y = 0.006108
RMS x = 0.02102
RMS y = 0.02021
0.15
0.1
0.05
-0
-0.05
-0.1
-0.15
-0.15
-0.1
-0.05
-0
0.05
0.1
0.15


RMS of U (segment angle - track angle) (rad)
hSigu
Nent = 6056
Mean = 0.004595
RMS = 0.002074
10²
10
1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


RMS of V (segment angle - track angle) (rad)
hSigv
Nent = 6056
Mean = 0.004577
RMS = 0.001984
10²
10
1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

Result

- The candidate event has 94 stopping-and-exiting track matches to the spectrometer track
- the single track is in the high-muon-flux region
- I need
  - better alignment (reduce # of stopping tracks)
  - refined analysis

Root outlook

- The tree has been created
- A simple analysis is possible
- More work needs to be done
  - vertex branch
  - better implementation of spectrometer tracks
  - analysis routines
  - Nagoya routines
- I would like to encourage people to use it for emulsion analysis